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VL-2488-3-O

DEVELOPMENT OF ELECTROPHORETIC PROCESS FOR COATING T-53 AIR DIFFUSER, EXHAUST DIFFUSER, AND COMBUSTION CHAMBER HOUSING WITH "SERMETEL W"®

PHASE III TECHNICAL REPORT

K. A. Gebler

7 November 1967 - 21 January 1968

Prepared for

Headquarters, U. S. Army Aviation Materiel Command
St. Louis, Missouri 63166

By

Vitro Laboratories
West Orange, New Jersey 07052

Prepared Under

Contract No. DAAJ01-67-C-2207(G)

Vitro Job No. 2488

Vitro LABORATORIES
DIVISION OF VITRO CORPORATION OF AMERICA
200 Pleasant Valley Way, West Orange, N. J.

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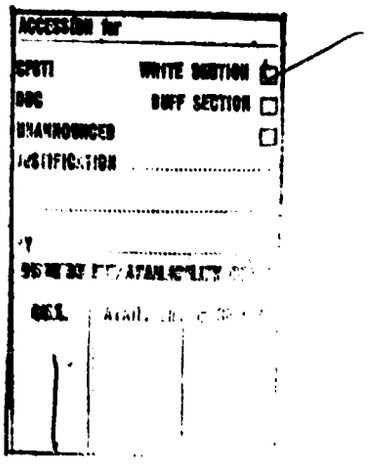

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ABSTRACT

This report covers activities accomplished during Phase III of a ten (10) month program to develop an electrophoretic coating method for the application of "SERMETEL®W"* to all critical surfaces of the exhaust diffuser, air diffuser and combustion chamber housing of the T-53 engine. "SERMETEL W" has been classified by various engine manufacturers and DOD agencies as the best coating available for corrosion protection.

During this phase a support fixture for loading, unloading and holding parts during coating was designed, fabricated and installed. A 200 VDC, 50 ampere power supply was checked out in coating experiments on combustion chamber segments and found to be in good working order. Full-scale electrode assemblies were completed for the air and exhaust diffuser components. Satisfactory humidification of coated panels and segments was obtained at 136°F and relative humidities of 61 and 66%. Metallurgical studies of combustion chamber housing segments indicated coatings of good uniformity and salt spray corrosion resistance.

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FOREWORD

This Phase III Technical Report covers work performed under Contract No. DAAJ01-67-C-2207(G) during the period 7 November 1967 - 21 January 1968.

This program is being conducted by the Chemistry and Arc Materials Department, West Orange Laboratory, Vitro Laboratories Division. The program is under the technical direction of F. E. Stevens, Directorate of Research, Development and Engineering, AVCOM, St. Louis, Missouri 63116.

Kenneth A. Gebler is the Vitro Project Leader. No other major contributions were made to this report by other persons.

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OBJECTIVES

The developmental effort under this program has two major objectives. The first is to develop the process methods and equipments to electrophoretically coat "SERMETEL W" on all critical surfaces of three T-53 engine components. These components, the exhaust diffuser, air diffuser, and combustion chamber housing are shown in Figures 1, 2, and 3, respectively.

The second objective, after successful coating procedures and equipment have been developed, is to coat a minimum of two parts of each type and deliver these parts to a site selected by the Contracting Officer for evaluation and qualification of the coating.

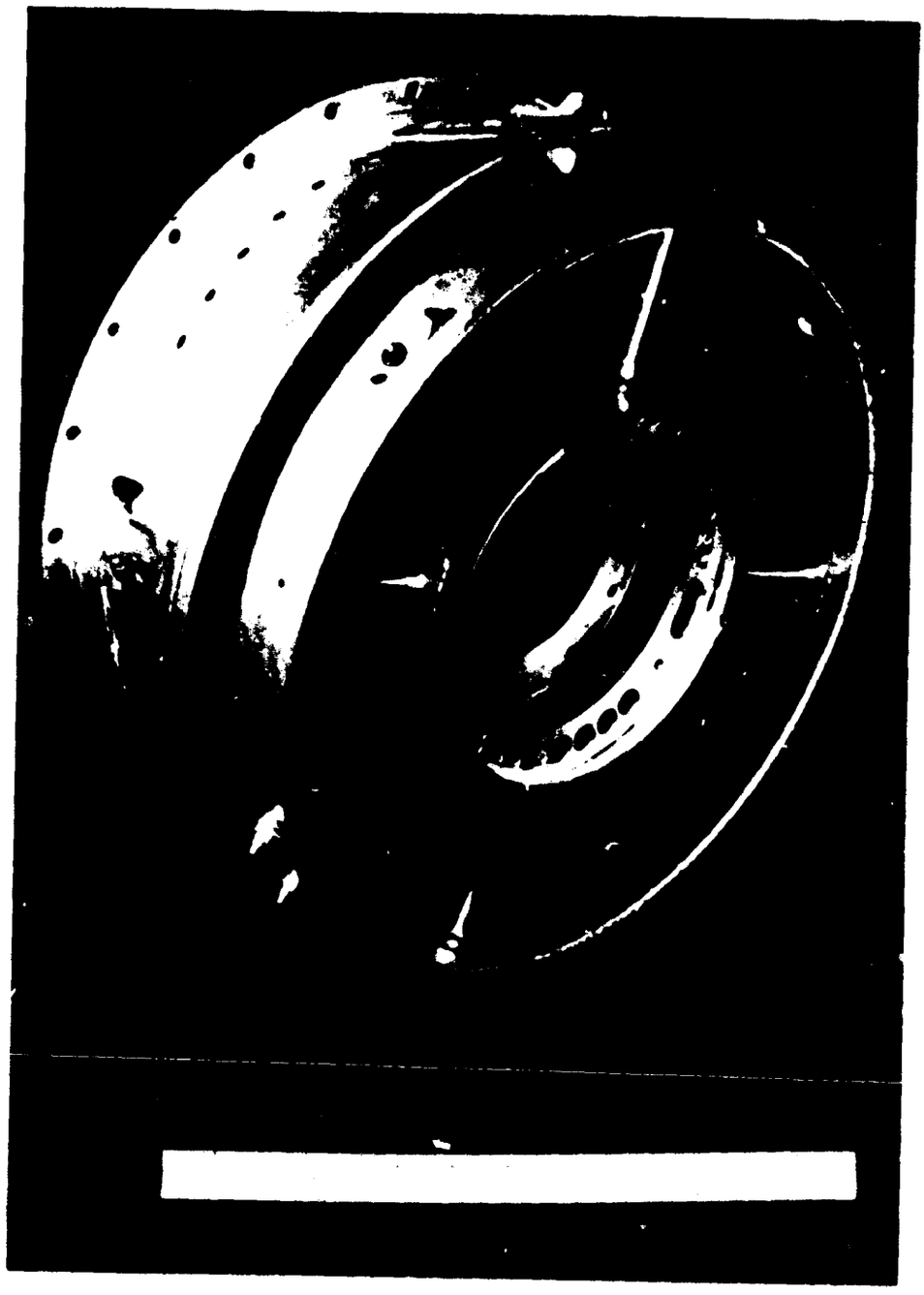


FIGURE 1

EXHAUST DIFFUSER FOR T-53 ENGINE
P/N 1-150-110-01

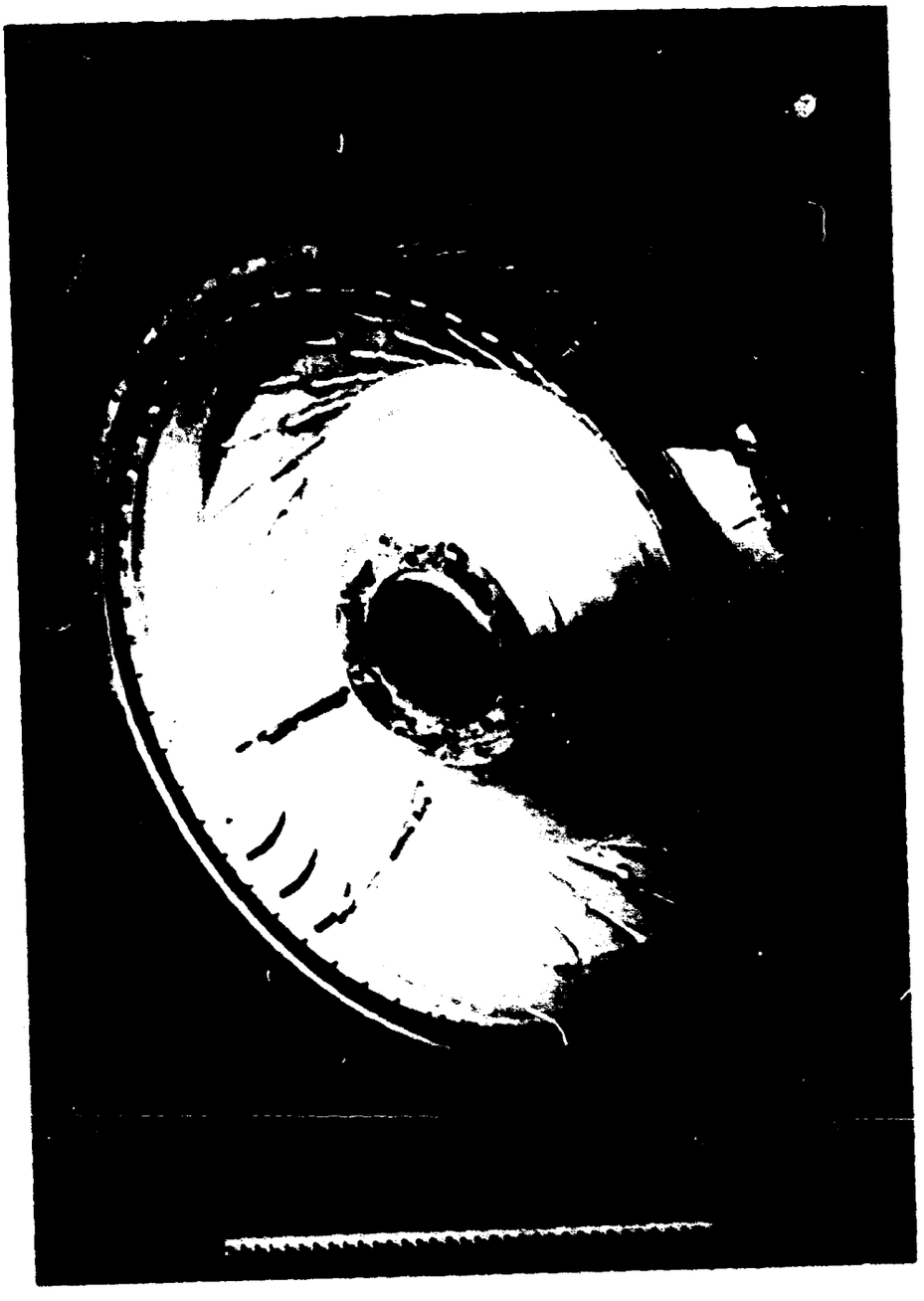


FIGURE 2

AIR DIFFUSER FOR T-53 ENGINE
P/N 1-110-230-01

FIGURE 3

COMBUSTION CHAMBER HOUSING FOR T-53 ENGINE
P/N 1-130-020-05

PROGRAM PLAN

The developmental effort has been divided into five essential phases:

I. Design and Installation of Coating Equipment

II. Dummy Coating Runs and Refinement of Electrode Design

III. Heat Treatment and Evaluation of Coated Components

IV. Full Scale Coating Trials

V. Delivery of Final Specimens

Through necessity, the work in each of the five phases will overlap and efforts will, therefore, be concurrent in one or more phases as the program progresses.

EXPERIMENTAL PROGRESS

Phase I - Design and Installation of Coating Equipment

A. Support Fixture

During this period a support fixture for holding the parts during coating was designed, fabricated and installed. It consists of two L-shaped steel arms which can be made to move in an arc by means of a set of gears and turning handle. Photographs of the support fixture with a combustion chamber housing and anode in two positions, loading or unloading and over the coating tank are shown in Figure 4.

B. Power Supply

The 200 VDC, 50 ampere power supply was checked out in November and used for power in coating several segments cut from a combustion chamber housing. It was determined from trial runs that a timing device and a 200 ohm, 250 watt resistor would be necessary for efficient and safe operation. These devices are in process of being installed.

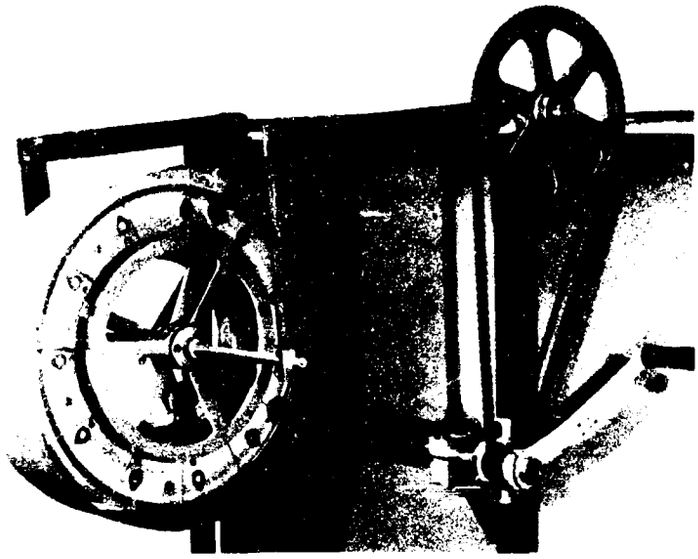
Phase II - Dummy Coating Runs and Refinement of Electrode Design

The first trial electrode assemblies for the full size air and exhaust diffusers were completed during this period. Several views of each are shown in the photographs of Figures 6 and 7. For comparison, the full size electrode assembly for the combustion chamber housing reported in the last progress report is shown in Figure 5.

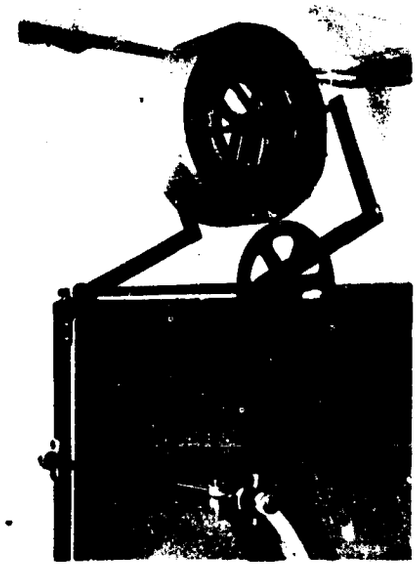
Phase III - Heat Treating and Evaluation of Components

A. Humidification Studies

Coated trial panels as well as segments cut from parts were humidified after coating in a chamber with a 136°F dry bulb temperature and a relative humidity of 61%. In general, it was necessary to treat the parts under these conditions for 16 hours in order to dissolve the dry binder material in the coating and to improve the smoothness of the coating surface. Humidification studies were also made with the chamber at 136°F dry bulb temperature and a relative humidity of 66%. Under these conditions satisfactory humidification



Loading or Unloading Position



Position Prior To Immersion

FIGURE 4

SUPPORT FIXTURE

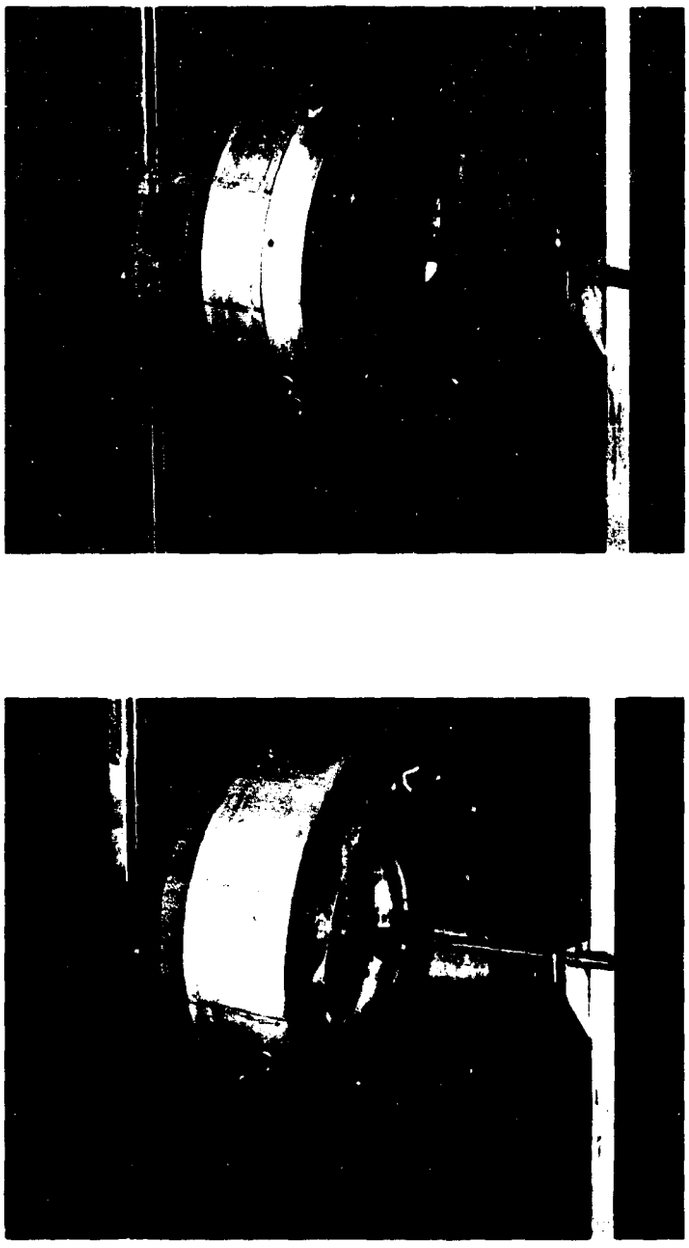


FIGURE 5

FULL SIZE ELECTRODE ASSEMBLY
FOR COMBUSTION CHAMBER HOUSING

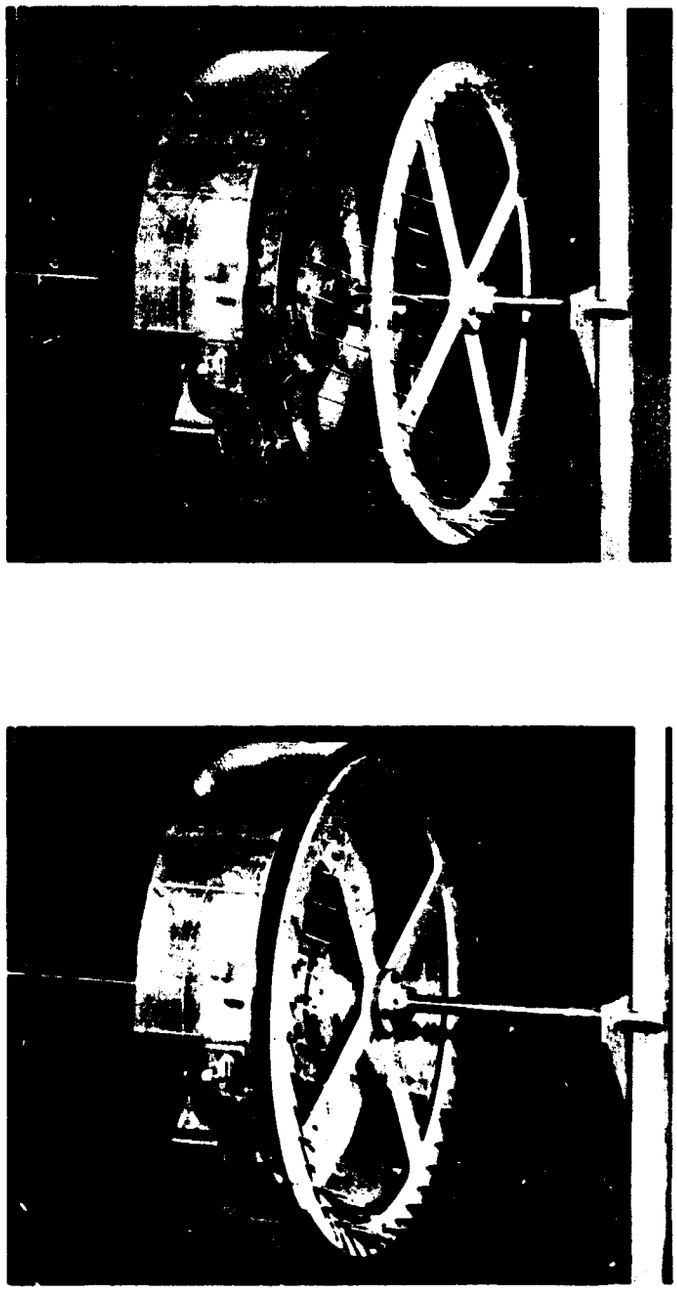


FIGURE 6

FULL SIZE ELECTRODE ASSEMBLY
FOR AIR DIFFUSER

FIGURE 7

FULL SIZE ELECTRODE ASSEMBLY
FOR EXHAUST DIFFUSER

of the coatings was obtained in as little as 2-1/2 to 3 hours. Other tests with the relative humidity at 71% caused excess moisture to be formed on the surfaces of specimens. Undesirable dripping and running of the wet binder occurred.

B. Metallographic Studies

Studies were made during this period of the structure and uniformity of the electrophoretically deposited SERMETEL W coating. For these studies the specimens were taken from the side wall of the combustion chamber housing segments which had been processed and then tested for 48 and 60 hours in a 5% NaCl spray corrosion chamber at 120°F. Excellent performance of the coating in protecting the steel substrate from the corrosive and rusting effects of the warm salt water-vapor atmosphere was obtained. The photomicrographs, Figure 8, show the typical structure of these electrophoretic SERMETEL W coatings. Good uniformity is evident. A recessed metal-to-metal joint cross section is alsc shown in Figure 8 to illustrate what may be a more difficult area in the efforts to obtain complete coating coverage on these complex engine components.

C. Corrosion Tests

Both uncoated and coated segments of a combustion chamber housing were exposed for a nominal test of 60 hours in the salt fog test apparatus to determine the effect of the warm salt vapor on the parts. The pieces, after testing, are shown in Figure 9. It can be seen that the uncoated steel has oxidized badly over most of the surfaces. The coated part withstood the effects of the corrosive atmosphere quite well. Oxidation can be found in seam and joint areas but this is minimal, and it is expected that these areas can be improved in future coating trials.

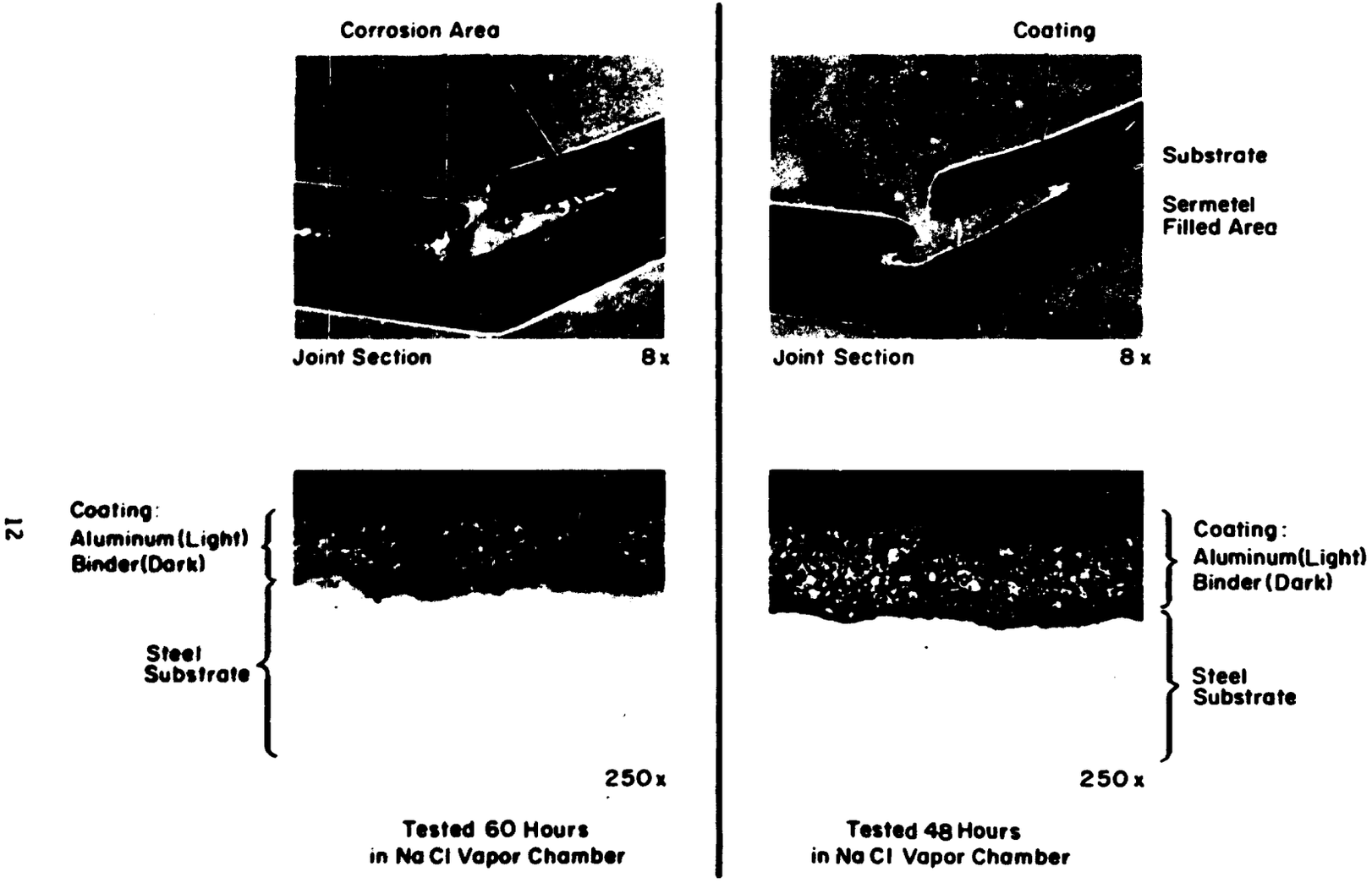


FIGURE 8

CROSS-SECTION PHOTOMICROGRAPHS OF
SERMETEL W COATED COMBUSTION
CHAMBER HOUSING SECTIONS

COATED UNCOATED

FIGURE 9

TEST SPECIMENS AFTER 60 HOUR
EXPOSURE TO SALT FOG

FUTURE WORK

1. Clean full scale components chemically in preparation for coating trials.
2. Prepare a 300 gallon electrophoretic SERMETEL W coating dispersion.
3. Run full scale coating trials.

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